Please add new claim 13 as follows:

13. (New) A self-sustained pulsating laser diode having a double-heterostructure comprising:

a first cladding layer of a first conductivity type;

a multi-quantum well active layer; and

a second cladding layer of a second conductivity type each being arranged on a semiconductor substrate of the first conductivity type, the number of said quantum wells being at least 5;

said layer thickness of a flat part of said second cladding layer having a current blocking structure being at least 300 nm; and a carrier density in a flat part of said second cladding layer having a current blocking structure is at least $1x10^{17}cm^{-3}$ and no greater than $5x10^{17}cm^{-3}$.

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REMARKS

Reconsideration of this application based on the foregoing Amendment and the following Remarks, in conjunction with the accompanying Request for Approval of Drawing Changes, is respectfully requested.

At the outset, prior to addressing any of the prior art rejections, the applicants call to the Examiner's attention that the applicant has added new claim 13. New claim 13 recites in part the number of quantum wells being at least 5; the layer thickness of a flat part of said second cladding layer having a current blocking structure is at least 300 nm; and a carrier (impurity) density in said flat part of said second cladding layer having a current blocking structure is at least $1x10^{+17}/cm^3$ to no greater than $5x10^{+17}/cm^3$. Each of these limitations appears in either of existing

claims 1, 2 or 9. Also, page 6, lines 16-28, also discloses these limitations. Therefore, no new matter has been added.

Although it was not cited by the Examiner, the applicants have also amended claims 1, 2 and 9 to delete the term "each" and amend the limitation of "a second cladding layer of a second conductivity type [each], both the first cladding layer and the second cladding layer being arranged on a semiconductor substrate of the first conductivity type," to improve claim form. No new matter has been added.

Response to Arguments

The Examiner indicates that he has considered the applicant's arguments with respect to claims 1-12 but the arguments are moot in view of new grounds of rejection.

The Examiner indicates also that regarding claims 9-12, which pertain to the difference in refractive index (Δn) parallel to the layers, that it is impermissible importation of subject matter from the specification into the claim. Reference is made to MPEP 2111.

35 U.S.C. 112, Second Paragraph Rejections: Claims 2, 4, 6, 8-12

The Examiner now rejects only claims 2, 4, 6 and 8-12 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter the applicant regards as the invention.

Regarding claims 2, 4, 6, 8-12, the Examiner indicates that it is unclear which layer has a difference of refractive index (Δn) when the applicant recites the limitation of "an effective refractive index parallel to the layers", since the claim recites limitations to cladding layers and multi-quantum layers.

This pertains also to the Examiner's remark regarding claims 9-12, which pertain to the difference in refractive index (Δn) parallel to the layers, that is impermissible importation of subject matter from the specification into the claim. Reference is made to MPEP 2111.

Essentially, the applicants are of the understanding that the Examiner is rejecting the amendment to claim 2 of "parallel to the layers", which affects the dependent claims 4, 6 and 8. The Examiner is similarly rejecting the amendment to claim 9, which affects also dependent claims 10-12. Although "the layers" is disclosed in the specification, the Examiner is basing the rejection on the case law cited in MPEP 2111, i.e., *in re Prater,* 415 F.2d 1393, 1404-05, 162 USPQ 541, 55051 (CCPA 1969), which discloses the following: "reading a claim in light of the specification, to thereby interpret limitations explicitly recited in the claim, is a quite different thing from `reading limitations of the specification into a claim,' to thereby narrow the scope of the claim by implicitly adding disclosed limitations which have no express basis in the claim."

In response, the applicants maintain that the phrase "effective refractive index difference parallel to the layers" means literally that the effective refractive indices are different from each other in a lateral direction of the diode.

The phrase "the effective refractive index difference (Δn)" is used for a diode comprising a plurality of layers including the active layer or the like which are extending along the horizontal direction of the diode.

To support this argument, the applicants herein enclose pages 1981-1986 of Takayama et al, IEEE, Journal of Quantum Electronics, Volume 32, No. 11, which indicates in FIG. 2(a) and 2(b) on page 1983 that the effective refractive index

difference (Δn) between inside and outside the stripe in FIG. 2(b) is parallel to the layers in Fig. 2(a) with respect to the x-y-z axes as shown.

FIG. 2(a) of Takayama et al shows the effective refractive index of Region A, which corresponds to an area *inside of the stripe* and the effective refractive index of Region B, which corresponds to an area *outside of the stripe.* The effective refractive index difference (Δn) between the layers inside and outside the stripe is calculated based on this information.

FIG. 2(b) shows the distribution of the effective refractive indexes in the horizontal or lateral direction. Therefore, the effective refractive index difference between Region A and Region B is represented by Δn.

Accordingly, since the definition of the effective refractive index difference (Δn) between the layers inside and outside the stripe was known and would have been understood by one of ordinary skill in the art at the time the invention was made, the applicants have amended the paragraph on page 3, lines 10-19, of the specification to read --although it is effective to make <u>an effective</u> refractive index parallel to the layers <u>between</u> inside and outside the <u>stripes</u>--. Therefore, no new matter has been added to the specification.

As a result, the applicants respectfully request the Examiner to withdraw the rejections of claims 2, 4, 6 and 8-12 for indefiniteness under 35 U.S.C. 112, second paragraph.

The applicants have also identified an obvious minor editorial error in the caption of FIG. 2(a) where "NUMBER OF MQW ACTIVE WALL LAYERS" should read "NUMBER OF MQW ACTIVE WELL LAYERS". The applicants are

enclosing an accompanying Request for Approval of Drawing Changes to correct the error.

35 U.S.C. 102(b) Rejecti ns: Claims 9-12

The Examiner has rejected claims 9-12 under 35 U.S.C. 102(b) as now being anticipated by Tanaka et al (US 4,961,197 - filed April 14, 1989 - issued October 2, 1990).

The Examiner asserts that Tanaka et al, column 4, lines 14-18, discloses a self-sustained pulsating semiconductor laser device with active layers having an effective refractive index within a range of $8x10^{-4}$ to $5x10^{-3}$. The Examiner also asserts in part that Tanaka et al, column 20, discloses a cladding layer 48 that is 0.4-0.6 μm thick and has an impurity density of $6x10^{+17}$ /cm^3.

In response, the applicants maintain that the present invention includes all or part of the following limitations.

1. the number of quantum wells is at least 5 (and no greater than 10).

2. a layer thickness of a flat part of said second cladding layer having a blocking structure being at least 300 nm (0.3 μm) (and no greater than 500nm, 0.5 μm).

3. a carrier (impurity) density, in a flat part of the cladding layer having a blocking structure, of at least $1x10^{+17}$ /cm^3 to no greater than $5x10^{+17}$ /cm^3

A fourth limitation is the following:

4. an effective refractive index difference parallel to the layers (Δn) being at least $7x10^{-4}$ and no greater than $3x10^{-3}$.

The foregoing limitations are disclosed in the specification in page 4, lines 25-27, page 5, lines 7-9, page 8, line 28, to page 9, line 10, and also on page 9, lines 22-28.

FIGS. 2(a) to 2(c) of the present application, and the accompanying disclosure in the specification on page 11, line 1 to page 12, line 3, indicates the unexpected results of the increase in the Maximum Temperature for Self-Excited Oscillation above the reference temperature of 70°C obtained by the combination of the ranges of limitations 1-3.

In contrast, Tanaka et al, which is cited by the Examiner, in FIG. 16, and column 20, lines 5-7, discloses the following:

(a) a cladding layer 48 that is 0.4-0.6 μm thick

(b) an impurity (carrier) density in the cladding layer of $6x10^{+17}$ /cm^3

Tanaka et al, column 7, lines 1-13, discloses the following:

(c) a multi-quantum well active layer

(d) density of impurities doped in the bulk active layer or in the multi-quantum well active layer can be $7x10^{+18}$ to $1x10^{+19}$ /cm^3 n-type and $5x10^{+17}$ to $5x10^{+18}$ /cm^3 p-type.

Tanaka et al, column 4, lines 14-18, discloses the following:

(e) The thickness of the portions of the upper cladding layer in which no ridge stripes is formed is controlled such that the effective refractive index difference between the area below the ridge stripe and other areas in the active layer is $8x10^{-4}$ to $5x10^{-3}$.

Tanaka et al, column 5, lines 40-42, discloses the following:

(f) Conventionally, it is known that by the use of a <u>single quantum well structure</u> in the active layer the threshold current for the laser oscillation is reduced.

Tanaka et al, column 17, lines 45-48, discloses the following:

(g) <u>a multi-quantum well structure active layer</u> of five (5) quantum barriers and *four (4) quantum wells.*

Tanaka et al, EXAMPLE 4, Col. 15, lines 19-22, discloses the following:

(h) "an undoped or n- or p-multiquantum well layer 24 (of three-six alternate quantum barriers and wells...).

Specifically with respect to claims 9 and 10, the applicants respectfully maintain that claim 9 recites implicitly a single multi-quantum well structure explicitly having *at least five (5) quantum wells.* Nowhere does Tanaka et al disclose, teach or suggest a multi-quantum well structure with *at least five (5) quantum wells.*

Consequently, claim 9 patentably distinguishes over Tanaka et al. Therefore, the applicants respectfully request the Examiner to withdraw the rejections of claims 9 and 10.

Claim 11 depends from claim 1. Claim 12 depends from claim 2. The applicants maintain that claims 11 and 12 stand together with the arguments presented below for their base claims. In view of those arguments, the applicants respectfully request the Examiner to withdraw the rejections of claims 11 and 12.

<u>35 U.S.C. 103(a) Rejections: Claims 1-8</u>

The Examiner has rejected claims 1-8 under 35 U.S.C. 103(a) as being unpatentable over Tanaka et al.

The Examiner presents the same arguments with respect to claims 1-4 as presented against claims 9-12. However, the Examiner also asserts that although Tanaka et al discloses the claimed invention except for the cladding layer having a density of $5x10^{+17}$ /cm^3, but rather having a density of $6x10^{+17}$ /cm^3, that it would have been obvious to design a cladding layer with a density of $5x10^{+17}$ /cm^3 because the general conditions of the invention have been disclosed by the prior art. Therefore, discovering an optimum or working condition involves routine skill in the art.

In response, the applicants maintain that claim 1 recites implicitly a single multi-quantum well structure explicitly having *at least five (5) quantum wells.* Nowhere does Tanaka et al disclose, teach or suggest a multi-quantum well structure with *at least five (5) quantum wells.*

In addition, claims 1 and 2 recite a cladding layer flat part having a current blocking structure with a carrier density of at least $1x10^{+17}$ /cm^3 to *no greater than* $5x10^{+17}$ /cm^3, which significantly deviates from the value of $6x10^{+17}$ /cm^3 disclosed by Tanaka et al.

As noted previously, the applicants maintain that the limitations recited by claim 1 of at least five (5) quantum wells together with a carrier (impurity) density in a flat part of the cladding layer *no greater than* $5x10^{+17}$ /cm^3 yield unexpected results of an increase in the Maximum Temperature for Self-Excited Oscillation above the reference temperature of 70°C due to the combination of the ranges of the limitations of (1) at least five 5 and no greater than 10 quantum wells, (2) a second (p-type) clad layer flat part layer thickness, having a current blocking structure, of at least 300nm and no greater than 500nm, and (3) a

carrier (impurity) density, in a flat part of the cladding layer having a current blocking structure, of at least $1x10^{+17}$ /cm^3 to no greater than $5x10^{+17}$ /cm^3, as recited by claim 1.

Tanaka et al does not disclose, teach or suggest a carrier density in a flat part of the cladding layer *no greater than* $5x10^{+17}$ /cm^3 as recited by claim 2.

In view of the unexpected results obtained of the increase in the Maximum Temperature for Self-Excited Oscillation above the reference temperature of 70°C obtained by the combination of the limitations recited by claims 1 and 2, claims 1 and 2 patentably distinguish over Tanaka et al. As a result, the applicants respectfully request the Examiner to withdraw the rejections of claims 1-8.

The foregoing Amendment and Remarks, in conjunction with the accompanying Request for Approval of Drawing Changes, establish the patentable nature of all of the claims in the application, i.e., claims 1-12. New claim 13 has been added. No new matter has been added, wherefore, early and favorable reconsideration and issuance of a Notice of Allowance are respectfully requested.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned **"Version with markings to show changes made."**

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the Specification:

The paragraph on page 3, lines 10-19, has been amended as follows:

To widen the light distribution in the horizontal direction, although it is effective to make [a] an effective refractive index difference parallel to the layers[,] between inside and outside the [stripe] stripes (Δn) small, with the construction of the past, that is, one of a construction satisfying either or both of the conditions of four or fewer wells of the MQW active layer or a layer thickness in the flat part of the p-AlGaInP cladding layer of less than 300nm, it is not possible to achieve a [sufficient] sufficiently small value of Δn, thereby preventing enhanced self-sustained pulsating operation.

In the Claims:

Claim 1 has been amended as follows:

1. **(Twice Amended)** A self-sustained pulsating laser diode having a double-heterostructure comprising:

a first cladding layer of a first conductivity type;

a multi-quantum well active layer; and

a second cladding layer of a second conductivity type [each], both the first cladding layer and the second cladding layer being arranged on a semiconductor substrate of the first conductivity type, the number of said quantum wells being at least 5 and no greater than 10; and a layer thickness of a flat part of said second cladding layer having a current blocking structure being at least 300nm and no greater than 500nm; and a carrier density in said flat part of said second cladding

layer having a current blocking structure being at least $1x10^{17}cm^{-3}$ and no greater than $5x10^{17}cm^{-3}$.

Claim 2 has been amended as follows:

2. (Twice Amended) A self-sustained pulsating laser diode having a double-heterostructure comprising:

a first cladding layer of a first conductivity type;

a multi-quantum well active layer; and

a second cladding layer of a second conductivity type [each], both the first cladding layer and the second cladding layer being arranged on a semiconductor substrate of the first conductivity type,

an effective refractive index difference parallel to the layers (Δn) being at least $7x10^{-4}$ and no greater than $3x10^{-3}$, and a carrier density in

a flat part of said second cladding layer having a current blocking structure being at least $1x10^{17}cm^{-3}$ and no greater than $5x10^{17}cm^{-3}$.

Claim 9 has been amended as follows:

9. (Amended) A self-sustained pulsating laser diode having a double-heterostructure comprising:

a first cladding layer of a first conductivity type;

a multi-quantum well active layer; and

a second cladding layer of a second conductivity type [each], both the first cladding layer and the second cladding layer being arranged on a semiconductor substrate of the first conductivity type, the number of said quantum wells being at least 5; and

a layer thickness of a flat part of said second cladding layer having a current blocking structure being at least 300nm; and an effective refractive index difference parallel to the layers (Δn) being at least $7x10^{-4}$ and no greater than $3x10^{-3}$.

New claim 13 has been added.